

ARSET

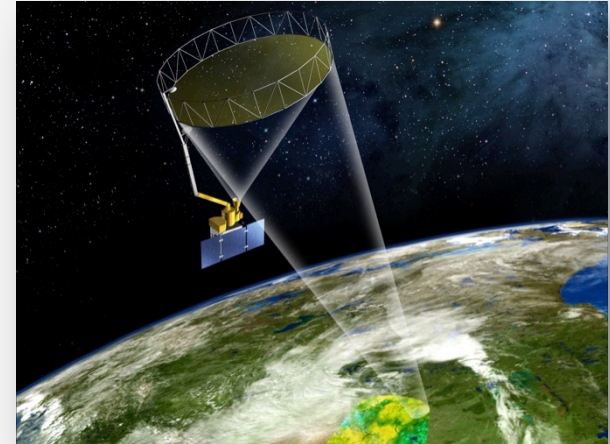
Applied Remote Sensing Training

<http://arset.gsfc.nasa.gov>

 @NASAARSET

SMAP Hands-On

Jul. 20, 2016



Outline

1. Data products overview
2. Discovering and downloading the data
3. Visualizing the data
4. Analyzing the data

The background of the slide is a composite image. It features a large satellite dish antenna, similar to the Arecibo radio telescope, floating in space. The dish is white with a green interior and a complex support structure. It is pointed towards the Earth, which is visible at the bottom of the frame. The Earth shows green landmasses, blue oceans, and white clouds. A semi-transparent grey rectangular box is overlaid on the image, containing the title text. The sky is dark with many stars.

Data Products Overview


Data Set ID	Data Set Description	Gridding Resolution	Temporal Coverage	DAAC
SPL1AA	L1A Radar Time-Ordered Parsed Telemetry	—	4/13/15 – 7/7/15	ASF
SPL1BS0	L1B Radar Half-Orbit Time-Ordered Low-Resolution so Data	5x30 km	4/13/15 – 7/7/15	ASF
SPL1CS0	L1C Radar Half-Orbit High-Resolution Radar so Data	1 km	4/13/15 – 7/7/15	ASF
SPL1AP	L1A Radiometer Time-Ordered Parsed Telemetry	—	3/31/15 – present	NSIDC
SPL1BTB	L1B Radiometer Half-Orbit Time-Ordered TB	36x47 km	3/31/15 – present	NSIDC
SPL1CTB	L1C Radiometer Half-Orbit EASE-Grid TB	36 km	3/31/15 – present	NSIDC
SPL2SMA	L2 Radar Half-Orbit EASE-Grid Soil Moisture	3 km	4/13/15 – 7/7/15	NSIDC
SPL2SMP	L2 Radiometer Half-Orbit EASE-Grid Soil Moisture	36 km	3/31/15 – present	NSIDC
SPL2SMAP	L2 Radar/Radiometer Half-Orbit EASE-Grid Soil Moisture	9 km	4/13/15 – 7/7/15	NSIDC
SPL3FTA	L3 Radar N. Hemisphere Daily EASE-Grid Freeze/Thaw State	3 km	4/13/15 – 7/7/15	NSIDC
SPL3SMA	L3 Radar Global Daily EASE-Grid Soil Moisture	3 km	4/13/15 – 7/7/15	NSIDC
SPL3SMP	L3 Radiometer Global Daily EASE-Grid Soil	36 km	3/31/15 – present	NSIDC
SPL3SMAP	L3 Radar/Radiometer Global Daily EASE-Grid Soil Moisture	9 km	4/13/15 – 7/7/15	NSIDC
SPL4SMAU	L4 Global Surface & Root Zone Soil Moisture Analysis Update	9 km	3/31/15 – present	NSIDC
SPL4SMGP	L4 Global Surface & Root Zone Soil Moisture Geophysical Data	9 km	3/31/15 – present	NSIDC
SPL4CMDL	L4 Global Daily Carbon Net Ecosystem Exchange (NEE)	9 km	4/13/15 – present	NSIDC

Product Configuration

- **All products are in HDF5 format**
 - Each SMAP HDF5 file contains the primary data parameters (e.g., soil moisture, freeze/thaw, sensor data) and all data used in the production of those primary parameters. These files also include metadata, geolocation information, quality flags, etc.
- **Projection: EASE-Grid 2.0**
 - Equal-area projection
 - Level 2, 3, 4, and radiometer L1C are in this projection
- **Values**
 - Radiometer data (brightness temperature) is in Kelvin
 - Radar data is in sigma naught
 - Soil moisture is a volumetric measurement expressed as cm^3/cm^3
 - Freeze/thaw is a binary measurement, either frozen or thawed
 - Net ecosystem exchange is in grams of carbon/square meter per day

Product Configuration

- Values
 - The radiometer data (brightness temperature) are in Kelvin
 - The radar data are in sigma naught
 - Soil moisture is volumetric and expressed as cm^3/cm^3
 - Surface freeze/thaw state is a binary measurement
 - Net carbon ecosystem exchange is in grams per square meter per day

The background of the slide is a composite image. At the top, a large satellite dish with a white metal frame and a green interior is shown in space, pointing towards the Earth. A bright yellow beam of light originates from the dish and points down towards a specific region on the Earth's surface. The Earth is shown from space, with a curved horizon, white clouds, and green landmasses. In the bottom right corner, there is a rectangular area with a green and yellow color scale, resembling a weather or climate data visualization. The text 'Discovering and Downloading the Data' is centered in the middle of the image, underlined.

Discovering and Downloading the Data

Data Access: NSIDC

NSIDC DAAC: <http://nsidc.org/data/smap>

- Access to the L1 radiometer data and all L2, L3, and L4 radiometer and radar products.
- Data access, data set user guide documents, tools, news, published research, quality information, FAQs, and many other resources.

NSIDC National Snow & Ice Data Center

DATA RESEARCH NEWS ABOUT

SEARCH Web pages

NASA Distributed Active Archive Center (DAAC) at NSIDC

SMAP Data
Soil Moisture Active Passive Data

Overview

Data Sets
SMAP Data
Validation Data

Data Versions

Tools

FAQs

How Tos

Data Announcements

Published Research
SMAP Data
Validation Data

Overview

The NASA National Snow and Ice Data Center Distributed Active Archive Center (NSIDC DAAC) and the NASA Alaska Satellite Facility Distributed Active Archive Center (ASF DAAC) jointly manage SMAP science data on behalf of the NASA ESDIS Project. The NSIDC DAAC distributes validation campaign data and science data for the SMAP mission, including Level-1 through Level-4 radiometer data, Level-2 and Level-3 radar and combined radar/radiometer data, and Level-4 radiometer data. SMAP Level-1 radar data are available at the ASF DAAC.

Mapping Moisture

SMAP measures soil moisture across the entire Earth every three days, creating maps that help forecast crop productivity, and the risk of floods, drought, wildfires, and vector-borne diseases. [Read more ...](#)

RELATED RESOURCES

[SMAP Handbook](#)
Essential information on the programmatic, technological, and scientific aspects of SMAP data and the mission.

[SMAP Radar Data at the ASF DAAC](#)

[SMAP information at NASA](#)

[SMAP information at JPL](#)

[HDF5 Tools](#)

[EASE-Grid Data](#)

[NSIDC User Services](#)

ABOUT THE INSTRUMENT

Launched on 31 January 2015, the SMAP instrument includes a radiometer and a high-resolution radar to measure surface soil moisture and freeze-thaw state. The instrument was designed to make coincident measurements of surface emission and backscatter, and to sense soil conditions through moderate vegetation cover. With a swath width of 1,000 km, SMAP provides global coverage within three days at the equator and two days at boreal latitudes (greater than 45 degrees N).

Data Access: NSIDC















NSIDC DAAC: <http://nsidc.org/data/smap>

- HTTPS
 - <https://n5eil01u.ecs.nsidc.org/SMAP/>
- FTP
 - <ftp://n5eil01u.ecs.nsidc.org/SAN/SMAP>
- Direct access to the SMAP data

Index of <ftp://n5eil01u.ecs.nsidc.org/SAN/SMAP/>

 [Up to higher level directory](#)

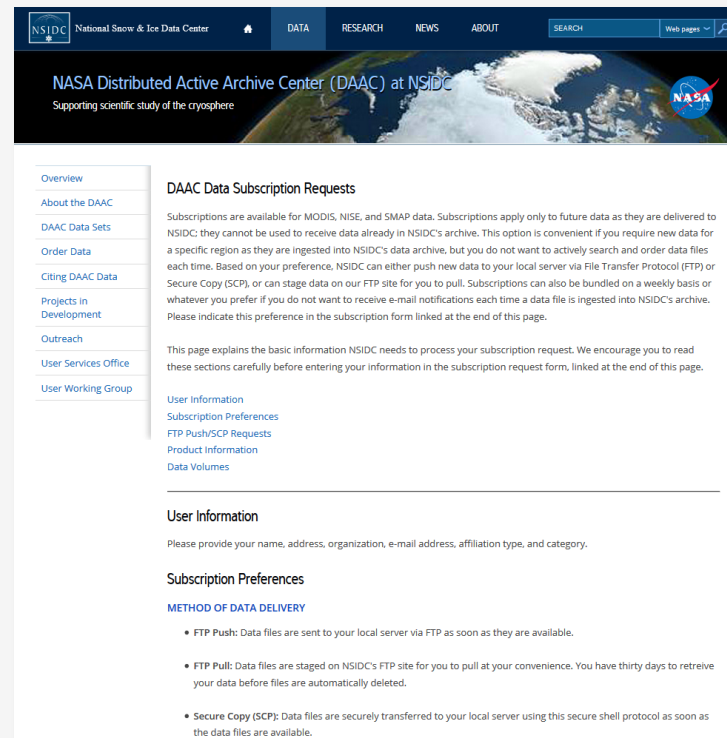
Name

-  [SPL1AP.002](#)
-  [SPL1BTB.002](#)
-  [SPL1CTB.002](#)
-  [SPL2SMA.002](#)
-  [SPL2SMAP.002](#)
-  [SPL2SMP.002](#)
-  [SPL3FTA.002](#)
-  [SPL3SMA.002](#)
-  [SPL3SMAP.002](#)
-  [SPL3SMP.002](#)
-  [SPL4CMDL.001](#)
-  [SPL4SMAU.001](#)
-  [SPL4SMGP.001](#)
-  [SPL4SMLM.001](#)

Data Access: NSIDC

Subscription: <http://nsidc.org/daac/subscriptions.html>

Automatic delivery of data as it becomes available.



The screenshot shows the NSIDC (National Snow & Ice Data Center) website. The header includes the NSIDC logo, navigation links (DATA, RESEARCH, NEWS, ABOUT), a search bar, and a language selector. Below the header is a banner for the NASA Distributed Active Archive Center (DAAC) at NSIDC, with the tagline "Supporting scientific study of the cryosphere" and a NASA logo. The main content area is titled "DAAC Data Subscription Requests" and contains the following text:

Subscriptions are available for MODIS, NISE, and SMAP data. Subscriptions apply only to future data as they are delivered to NSIDC; they cannot be used to receive data already in NSIDC's archive. This option is convenient if you require new data for a specific region as they are ingested into NSIDC's data archive, but you do not want to actively search and order data files each time. Based on your preference, NSIDC can either push new data to your local server via File Transfer Protocol (FTP) or Secure Copy (SCP), or can stage data on our FTP site for you to pull. Subscriptions can also be bundled on a weekly basis or whatever you prefer if you do not want to receive e-mail notifications each time a data file is ingested into NSIDC's archive. Please indicate this preference in the subscription form linked at the end of this page.

This page explains the basic information NSIDC needs to process your subscription request. We encourage you to read these sections carefully before entering your information in the subscription request form, linked at the end of this page.

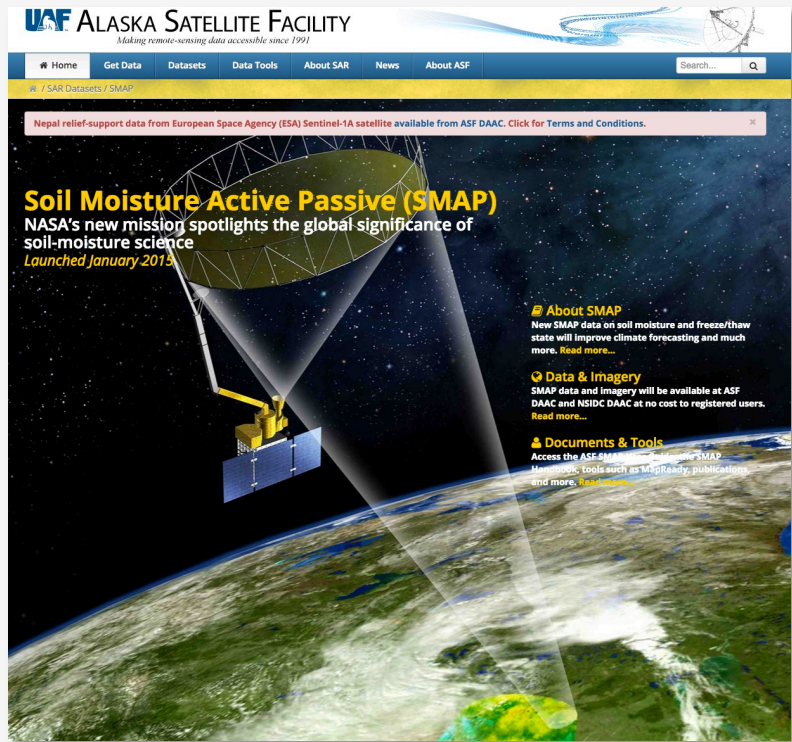
On the left side of the page, there is a sidebar with a list of links: Overview, About the DAAC, DAAC Data Sets, Order Data, Citing DAAC Data, Projects in Development, Outreach, User Services Office, and User Working Group. Below the main text, there are sections for "User Information" and "Subscription Preferences". The "Subscription Preferences" section includes a sub-section titled "METHOD OF DATA DELIVERY" with three bullet points:

- **FTP Push:** Data files are sent to your local server via FTP as soon as they are available.
- **FTP Pull:** Data files are staged on NSIDC's FTP site for you to pull at your convenience. You have thirty days to retrieve your data before files are automatically deleted.
- **Secure Copy (SCP):** Data files are securely transferred to your local server using this secure shell protocol as soon as the data files are available.

Data Access: ASF

ASF DAAC: <http://asf.alaska.edu/smap>

- Access to the L1 radar data only.
- Data access, data set user guide documents, tools, news, published research, quality information, FAQs, and many other resources.



The background of the slide is a composite image. It shows a satellite dish with a green interior and a white metal frame, positioned in space. The dish is pointed towards the Earth, which is visible as a curved horizon with green land, blue oceans, and white clouds. A large, semi-transparent white rectangular box is overlaid on the image, covering the central part of the dish and the Earth. Inside this box, the text "Data Visualization" is written in a black, sans-serif font. Below the text, a thin black horizontal line extends across the width of the text.

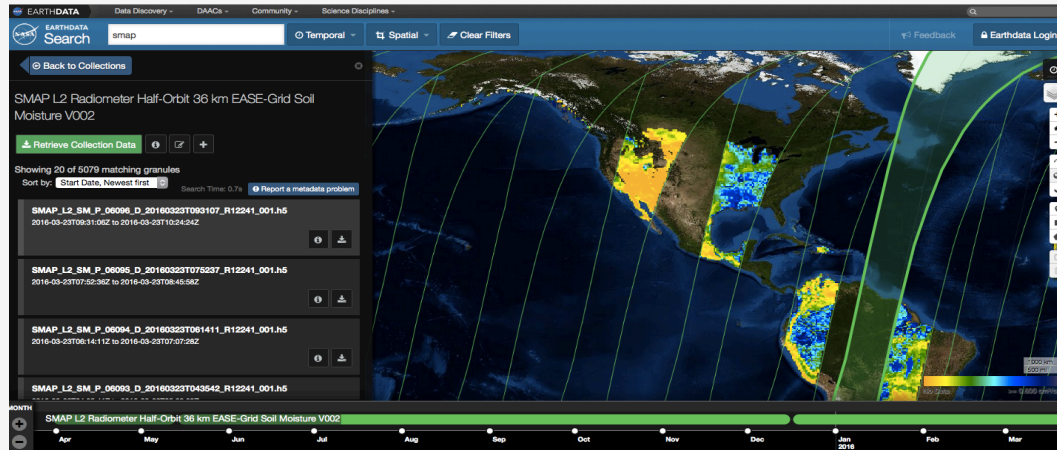
Data Visualization

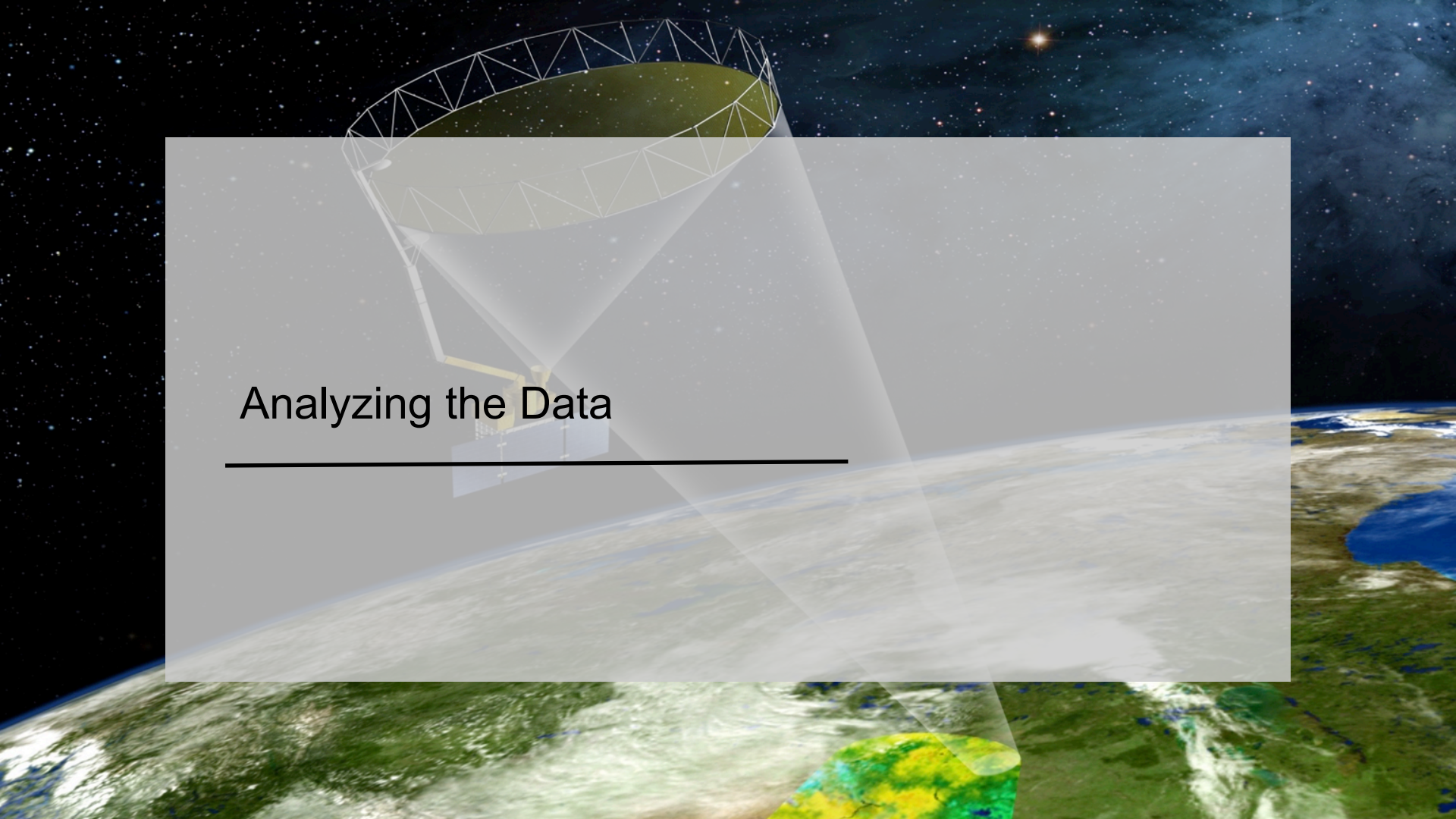
Visualizing the Data with Worldview

<https://earthdata.nasa.gov/worldview>

Earthdata Search: <http://search.earthdata.nasa.gov/>

- Search and order all SMAP data
- Keyword, spatial, and/or temporal search
- Reformat, reproject, and subset services for most products



A large satellite dish antenna is shown in space, pointing towards the Earth. The dish is white with a green interior and a yellow support structure. A wide, translucent white cone of light or data beam extends from the dish towards the Earth's surface. The Earth is visible as a curved horizon with green land, blue oceans, and white clouds. In the foreground, a colorful, abstract data visualization in shades of green, yellow, and red is visible. The background is a deep black space filled with stars and a bright star in the upper right.

Analyzing the Data

Tools for Reading SMAP Data

- HDF5

- http://www.hdfgroup.org/products/hdf5_tools/index.html

- Code in: Python, MATLAB, IDL, y NCL

- http://hdfeos.org/zoo/index_openNSIDC_Examples.php#SMAP

- Panoply

SMAP	Swath	SMAP_L1A_RADIOMETER_03721_D_20151013T000528_R11920_001.h5	Python	NCL	MATLAB	IDL
		SMAP_L1B_TB_01367_A_20150505T001706_R11850_001.h5	Python	NCL	MATLAB	IDL
		SMAP_L1C_TB_03721_D_20151013T000528_R11920_001.h5	Python	NCL	MATLAB	IDL
		SMAP_L2_SM_P_03721_D_20151013T000528_R11920_001.h5	Python	NCL	MATLAB	IDL
	Grid	SMAP_L3_SM_P_20151012_R11920_001.h5	Python	NCL	MATLAB	IDL

SOFTWARE USING HDF5

CONTENTS:

- [HDF5 Tools and Software](#)
- [HDF5 Tools by Category](#) (view, edit, export, convert, import)
- [Table \(Summary\) of Software Using HDF5](#)
- [HDF5 Command-line Tools](#)
- [Archived](#)

HDF5 Tools and Software:

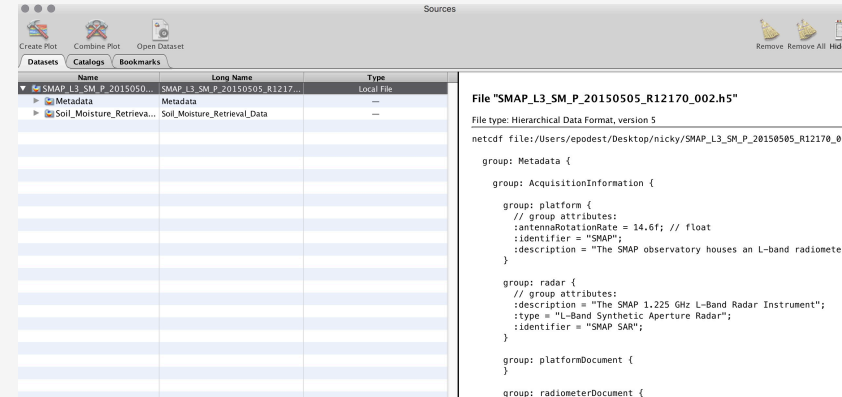
- [HDF~Java Products and HDFView](#): HDFView Java browser for HDF4 and HDF5 and HDF Java wrappers
- [HDF5 Command-line Tools](#): Tools included with the HDF5 distribution
- [HDF5 and .NET](#)
- [H4toH5 Conversion Library and Tools](#): A library and tools for converting to and from HDF4 and HDF5.
- [h5check](#): A tool to check the validity of an HDF5 file.
- [h5edit](#): A tool for editing an HDF5 file. The current (first) release only supports commands for the creation and deletion of attributes of datasets and groups. More commands will be implemented in the future. This software is sponsored by the JPSS project. **NEW**
- [HDF5 XML Information Page](#): DTD and tools for using HDF5 with XML.

See the [Downloads](#) page to access this tool:

- [h5fix_obj_nmmsgs](#): Corrects corrupt object header (rare problem prior to 1.6.6). Search on *Miscouted* [here](#).

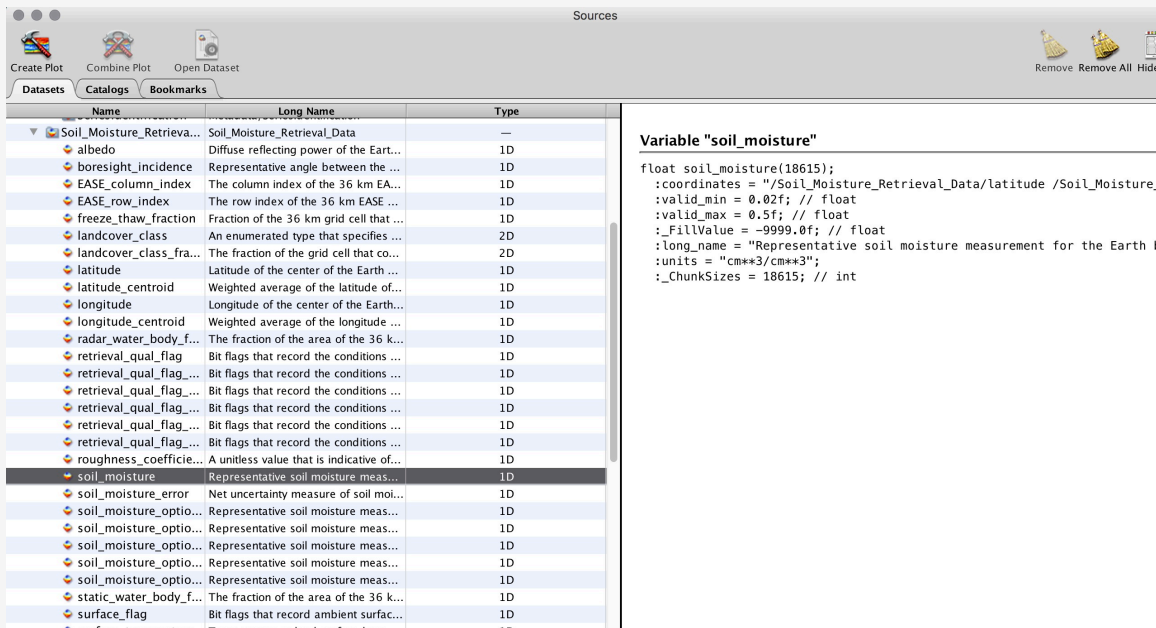
Opening a SMAP File with Panoply: L3 SM_P

1. Open Panoply
2. Go to File-Open and open your file
3. “SMAP_L3_SM_P_20150505_R12170_002.h5” The left window shows the archive structure, which has two folders: Metadata and Soil Moisture
4. Double click on an archive to see the files within it.



Opening a SMAP File with Panoply: L3 SM_P

- Click on soil moisture to see the characteristics or metadata of the file in the right window.



The screenshot shows the Panoply software interface. The 'Sources' window is open, displaying a list of datasets. The 'soil_moisture' dataset is selected. The right pane shows the metadata for this dataset.

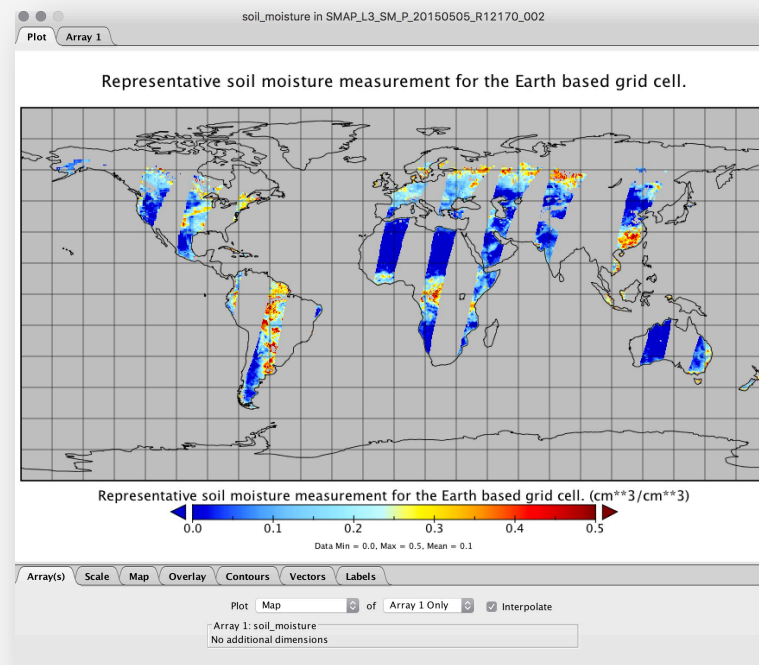
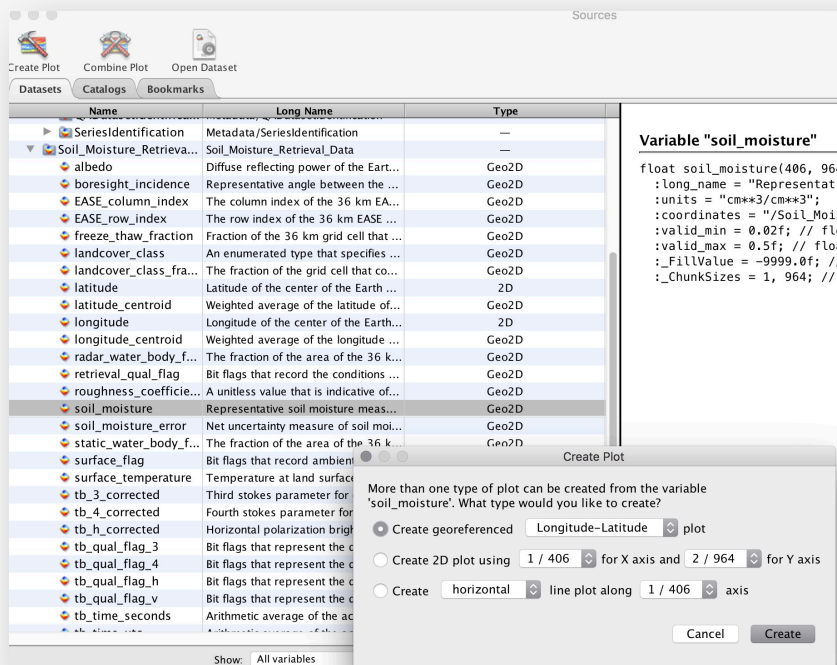
Name	Long Name	Type
Soil_Moisture_Retrieval...	Soil_Moisture_Retrieval_Data	—
albedo	Diffuse reflecting power of the Eart...	1D
boresight_incidence	Representative angle between the ...	1D
EASE_column_index	The column index of the 36 km EA...	1D
EASE_row_index	The row index of the 36 km EASE...	1D
freeze_thaw_fraction	Fraction of the 36 km grid cell that ...	1D
landcover_class	An enumerated type that specifies ...	2D
landcover_class_fra...	The fraction of the grid cell that co...	2D
latitude	Latitude of the center of the Earth...	1D
latitude_centroid	Weighted average of the latitude of...	1D
longitude	Longitude of the center of the Earth...	1D
longitude_centroid	Weighted average of the longitude ...	1D
radar_water_body_f...	The fraction of the area of the 36 k...	1D
retrieval_qual_flag	Bit flags that record the conditions ...	1D
retrieval_qual_flag_...	Bit flags that record the conditions ...	1D
retrieval_qual_flag_...	Bit flags that record the conditions ...	1D
retrieval_qual_flag_...	Bit flags that record the conditions ...	1D
retrieval_qual_flag_...	Bit flags that record the conditions ...	1D
retrieval_qual_flag_...	Bit flags that record the conditions ...	1D
roughness_coef...	A unitless value that is indicative of...	1D
soil_moisture	Representative soil moisture meas...	1D
soil_moisture_error	Net uncertainty measure of soil moi...	1D
soil_moisture_optio...	Representative soil moisture meas...	1D
soil_moisture_optio...	Representative soil moisture meas...	1D
soil_moisture_optio...	Representative soil moisture meas...	1D
soil_moisture_optio...	Representative soil moisture meas...	1D
soil_moisture_optio...	Representative soil moisture meas...	1D
static_water_body_f...	The fraction of the area of the 36 k...	1D
surface_flag	Bit flags that record ambient surfac...	1D

Variable "soil_moisture"

```
float soil_moisture(18615);
:coordinates = "/Soil_Moisture_Retrieval_Data/latitude /Soil_Moisture_
:valid_min = 0.02f; // float
:valid_max = 0.5f; // float
:_FillValue = -9999.0f; // float
:long_name = "Representative soil moisture measurement for the Earth b
:units = "cm**3/cm**3";
:_ChunkSizes = 18615; // int
```

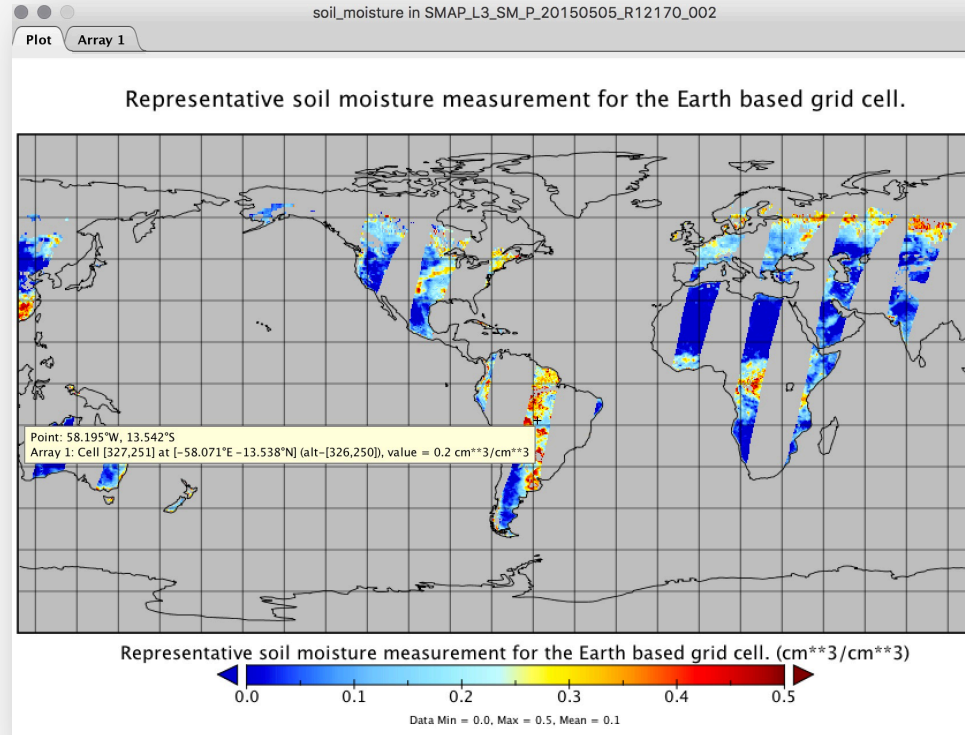
Opening a SMAP File with Panoply: L3 SM_P

6. Open the file as a map by double clicking on the soil moisture file



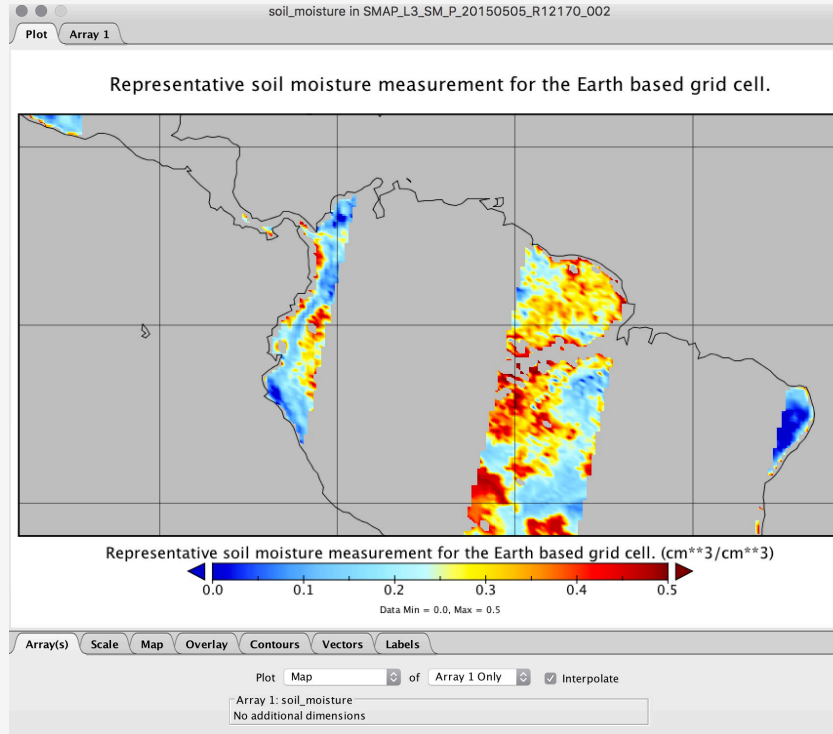
Displaying the Pixel Value on the Map: L3 SM_P

7. To see the pixel value place the cursor over the point of interest and click “Alt”



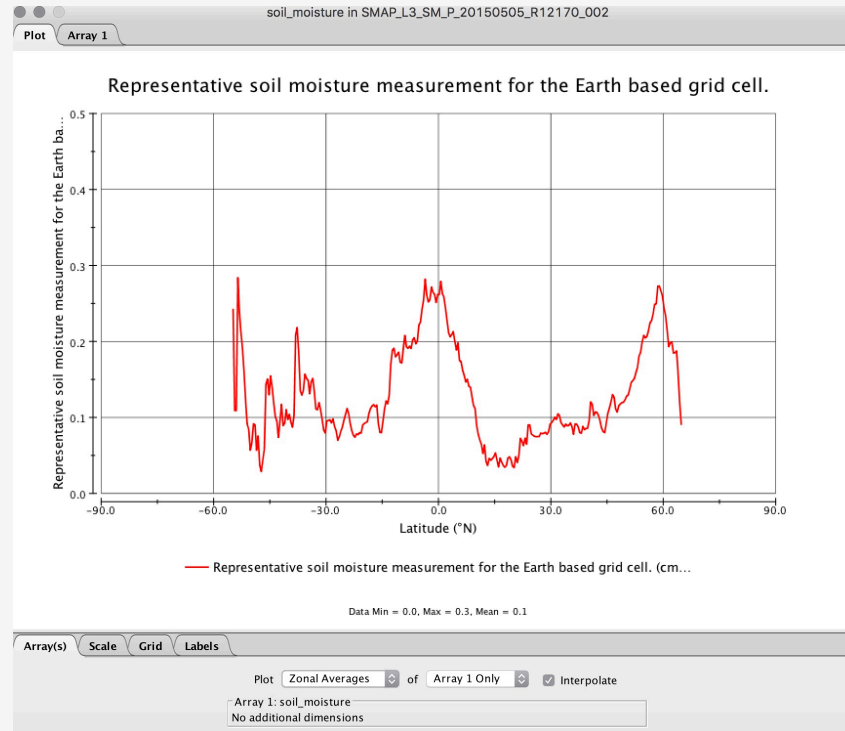
Zooming into the Image: L3 SM_P

8. To zoom into an area go to the top menu and select “Plot-Zoom In”



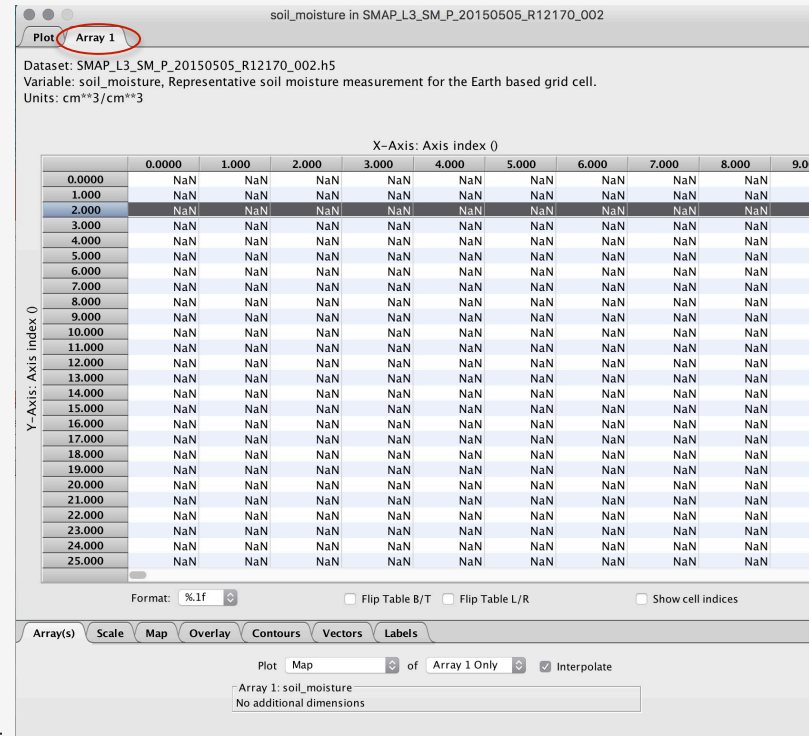
Plotting the Data: L3 SM_P

9. In the lower window select “Array-Plot” to create a plot of soil moisture as a function of latitude



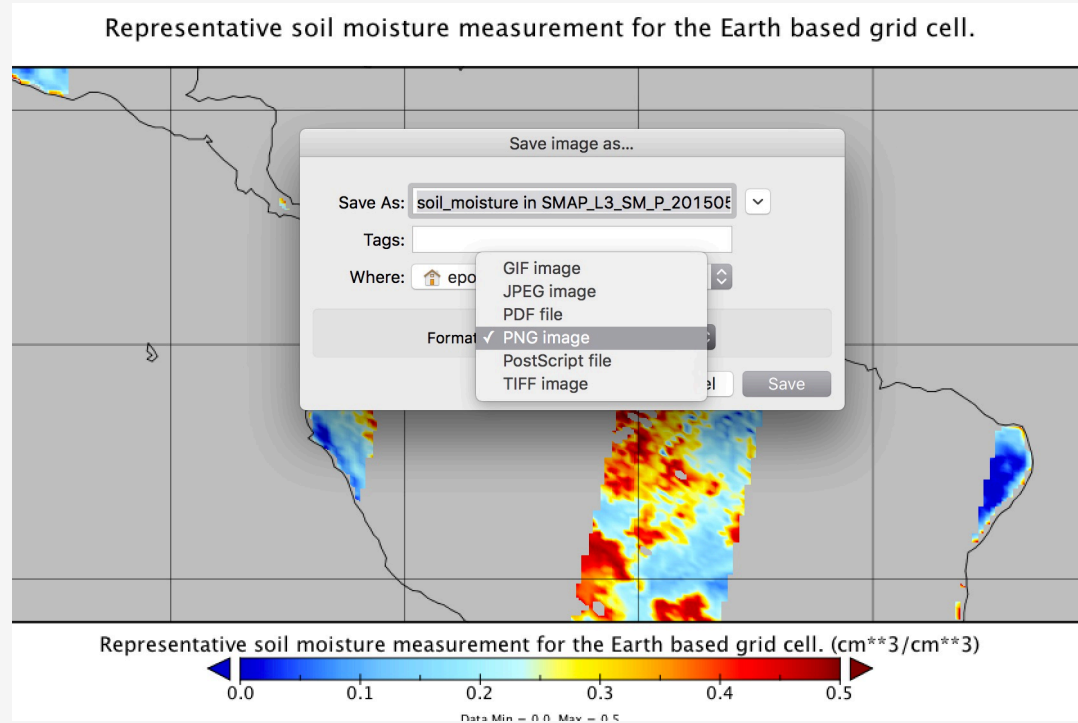
The File Values: L3 SM_P

10. Click on the tab option on the top that says “Array” in order to see the values in the file



Saving a File: L3 SM_P

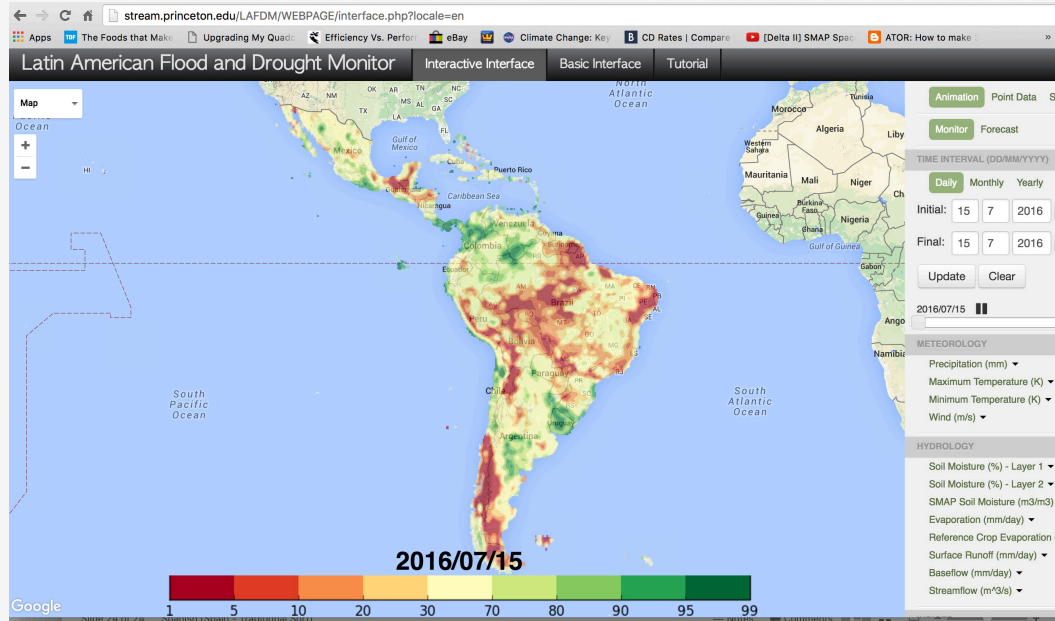
11. To save a file in a different format (e.g. Png, tiff, pdf) select "File-Save Image As" from the main menu



Extracting SMAP Soil Moisture

12. The most direct way to extract SMAP soil moisture values is using the "Latin American Flood and Drought Monitor" tool from Princeton University:

<http://stream.princeton.edu/LAFDM/WEBPAGE/interface.php?locale=en>



Extracting SMAP Soil Moisture Values

13. To extract soil moisture values from SMAP:

-in the upper right window select “Point Data”.

-in the next section under “Time Interval” specify the period of interest that you would like soil moisture. Note that SMAP soil moisture data is available as of mid-April 2015.

-in the next section select “SMAP soil moisture” and click on the map over your point of interest or manually specify your lat/lon using the “Manual Entry” option.

-in the last part under “Create Corresponding Data File” select “yes”

-Click on “Download Data” at the very bottom

Animation **Point Data** Spatial Data

TIME INTERVAL (DD/MM/YYYY)

Daily Monthly Yearly

Initial: 22 6 2016 - +

Final: 22 7 2016 - +

Update Clear

POINT DATA SELECTION

Map Click Manual Entry

Latitude: -17.309
Longitude: -52.910

☐ Indices
☐ Water Balance
☐ Surface Fluxes
☐ Streamflow
☐ Soil Moisture (Layer 1)
☐ Soil Moisture (Layer 2)
☒ **SMAP Soil Moisture**
☐ Reference Crop Evaporation
☐ Vegetation
☐ Meteorology

Create Corresponding Data File?

☒ **Yes**
☐ No

Download Data Only the last 1000 timesteps from the selected final date will be displayed

Extracting SMAP Soil Moisture Values

14. The data are downloaded directly to your computer as a text file

```
year,month,day,SMAP Soil Moisture - 1 day composite (m3/m3)
2016,6,22,-999.000
2016,6,23,0.110
2016,6,24,-999.000
2016,6,25,-999.000
2016,6,26,0.119
2016,6,27,-999.000
2016,6,28,-999.000
2016,6,29,0.123
2016,6,30,-999.000
2016,7,1,0.112
2016,7,2,-999.000
2016,7,3,-999.000
2016,7,4,0.120
2016,7,5,-999.000
2016,7,6,-999.000
2016,7,7,0.097
2016,7,8,-999.000
2016,7,9,0.112
2016,7,10,-999.000
2016,7,11,-999.000
2016,7,12,0.111
2016,7,13,-999.000
2016,7,14,-999.000
2016,7,15,-999.000
2016,7,16,-999.000
2016,7,17,-999.000
2016,7,18,-999.000
```

Exercise

15. From the same page download SMAP soil moisture data as well as vegetation and/or meteorological data for the same point. Plot them and explore correlations.